IMAGE APPRATUS AND METHOD FOR CALCULATING DEPTH

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This US non-provisional patent application claims priority under 35 USC §119 to Korean Patent Application No. 10-2015-0144221, filed on Oct. 15, 2015, the entirety of which is hereby incorporated by reference.

BACKGROUND

[0002] The present disclosure relates to image apparatuses and object depth calculation using object images captured by image apparatuses.

[0003] An image sensor is configured to convert an optical image into an electrical signal. With the recent advance in the computer industry and the communication industry, a demand for image sensors with improved performance is increasing in applications such as digital cameras, camcorders, personal communication systems (PCS's), game consoles, security cameras, medical microcameras, and robots. As the demand for such image sensors is increasing, a ulti-layer image sensor including multiple layers is being developed as a next generation age sensor in order to obtain more pixel information, for example, more color information.

[0004] In some cases, image apparatuses may be used to capture multiple optical images of an object. A distance between the object and image sensors of age apparatuses may be determined based on binocular disparity between separate images captured by different image sensors in an image apparatus.

SUMMARY

[0005] Example embodiments relate to image apparatuses configured to calculate a depth of an object according to local temperature and one or more captured images of the object.

[0006] According to some example embodiments, a method for calculating a depth of an object relative to an image apparatus, the image apparatus including a depth pixel array, the depth pixel array including a an image pixel, the image pixel including a left pupil sensor and a right pupil sensor, may include generating a left image of the object at the left pupil sensor, generating a right image of the object at a right pupil sensor, calculating a binocular disparity of the object based on the left image and the right image, measuring a local temperature value associated with the image pixel, calculating a corrected focal length associated with the image pixel based on the measured local temperature value, and calculating the depth of the object relative to the image apparatus, based on both the binocular disparity and the corrected focal length.

[0007] According to some example embodiments, a method may include measuring a first local temperature value associated with an image apparatus based on processing sensor data generated by at least one temperature sensor, performing a first contrast autofocus of at least one image captured by the image apparatus to calculate a first autofocus step code, based at least in part upon the measured first local temperature value, measuring a second local temperature value based on processing sensor data generated by the at least one temperature sensor, the second local temperature value being different from the first local temperature value, performing a second contrast autofocus of at least one image captured by the image apparatus to calculate a second autofocus step code, based at least in part upon the measured second local temperature value, and calculating a focal length variation based on both the first autofocus step code and the second autofocus step code.

[0008] According to some example embodiments, a method for calculating a depth of an object relative to an image apparatus, the image apparatus including an image sensor and a lens configured to direct incident light of the image sensor, may include capturing a plurality of images of the object at separate, respective portions of the image sensor, calculating a binocular disparity of the object based on the plurality of images, measuring a current local temperature value associated with the lens, performing a contrast autofocus of at least one image of the plurality of images to calculate an autofocus step code, based at least in part upon the measured current local temperature value, calculating a focal length variation based on both the autofocus step code and a second autofocus step code, the second autofocus step code being associated with a reference focal length of the lens, the reference focal length being associated with a reference local temperature value, calculating a corrected focal length of the lens based on the focal length variation, and calculating the depth of the object relative to the image apparatus, based on both the binocular disparity and the corrected focal length.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The forgoing and other features of inventive concepts will be described below in more detail with reference to the accompanying drawings of non-limiting embodiments of inventive concepts in which like reference characters refer to like parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating principles of inventive concepts. In the drawings:

[0010] FIG. **1** illustrates focal length difference depending on temperature when a distance between an object and a lens is infinite according to some example embodiments of the inventive concepts;

[0011] FIG. **2**A and FIG. **2**B illustrate image apparatuses according to some example embodiments of the inventive concepts;

[0012] FIG. **2**C illustrates focal length variation and a disparity difference depending on temperature in an image sensor according to some example embodiments of the inventive concepts;

[0013] FIG. **3** is a block diagram illustrating a method to calculate a focal length variation depending on temperature associated with an image sensor according to some example embodiments of the inventive concepts;

[0014] FIG. **4** is a block diagram illustrating a method to calculate a focal length variation depending on temperature associated with an image sensor **10** according to some example embodiments of the inventive concepts;

[0015] FIG. **5** is a flowchart illustrating a method for storing focal length variation depending on temperature of an image sensor according to some example embodiments of the inventive concepts;

[0016] FIG. **6** is a flowchart illustrating a depth calculation method of an image apparatus according to some example embodiments of the inventive concepts;